

Microcharon quilli, a new asellote isopod crustacean from interstitial spaces in shallow coralline sands off St. Eustatius, Caribbean Netherlands

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Abstract The genus *Microcharon* is known in the Caribbean from the widely separated islands of Bonaire and Cuba, occurring in brackish and freshwater subterranean environments. Here we describe a new species from reef sands off St. Eustatius, eastern Caribbean. Morphological differences are small between the eleven other marine or coastal groundwater *Microcharon* species that are known worldwide, and comparisons do not show a biogeographic pattern of sequential dispersion.

Keywords Crustaceans · Lepidocharontidae · Marine interstitial · Meiofauna · Systematics

Introduction

Lepidocharontid isopods have their largest radiation in the genus *Microcharon* with at least 70 species (Schotte 2007;

Coineau et al. 2013; Galassi et al. 2016), of which just a small part is marine (Coineau 1986). Most species of *Microcharon* are known from fresh groundwater habitats in countries around the Mediterranean, probably because of a long history of sampling efforts there by numerous zoologists. The marine species are found in shallow sandy bottoms, but no records are known from dredging samples of deeper seafloor sediment. The marine species are further known from intertidal and sandy beaches in the Caribbean, Mediterranean, Brittany (France), English Channel, Galapagos, and New Caledonia (Coineau et al. 2013; Albuquerque et al. 2014; Galassi et al. 2016).

Here we present the description of a new species of *Microcharon*, resulting from a 3-week sampling expedition at the leeward side of the volcanic island of St. Eustatius (Hoeksema 2016). *Microcharon quilli* n. sp. is described from six places in coralline white sands between submerged lava outcrops in Oranjestad Bay and Jenkins Bay (Fig. 1b).

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Nomenclatural acts herein are registered as follows: Species *Microcharon quilli* urn:lsid:zoobank.org:act:58F78412-0A08-4716-9970-B3EC1ECDB5AA

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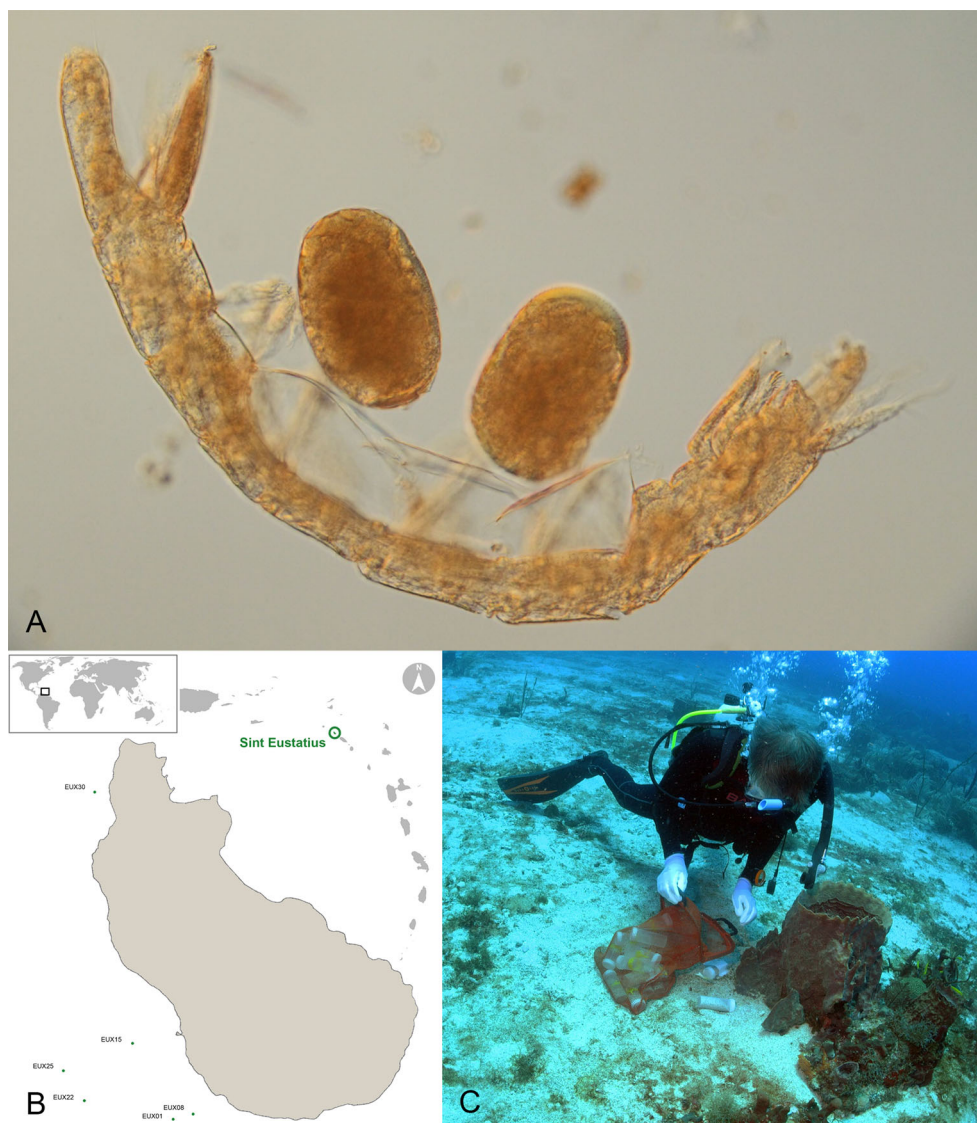
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Materials and methods

The 73 specimens of the new species were collected from several sites by means of scuba diving at depths between 2 and 25 m. Samples were collected by hand-pushing plastic probing tubes of 12 cm length and 2.5 cm diameter into the sand at selected places. Stations of these dive localities (with EUX numbers) are indicated by Hoeksema (2016). At each sampling site, the top layer of coarse reef sand was thick enough, allowing vertical to slightly skewed probing. The top of the tube contained a small hole for the escape of excess water. After closing the top, which creates a vacuum preventing the sediment from spilling, the tube was carefully removed and quickly shut at the opening (Fig. 1c). The samples were sorted in the laboratory of CNSI (Caribbean Netherlands Science Institute; Oranjestad, St. Eustatius) under a

Fig. 1 **a** *Microcharon quilli* n. sp. paratype, RMNH.CRUS.7718, female 1.5 mm, carrying eggs. Antennae and uropods broken off. **b** Map of St. Eustatius with offshore sampling sites. **c** Sampling method, filling tubes with sediment at selected sites (photo A. Speksnijder)



dissecting microscope and transferred to 96% ethanol. Before dissection, specimens were treated with lactic acid to soften the cuticle and remove internal tissues to facilitate observation. Drawings were prepared using a camera lucida on an Olympus BX 53 microscope equipped with differential interference contrast (DIC). Specimens and appendages preserved on slides were mounted in Faure's medium and the coverslips sealed with transparent nail varnish. Specimens have been deposited in the Crustacea collection of Naturalis Biodiversity Center in Leiden with catalogue numbers RMNH.CRUS.

Taxonomy

Order Isopoda Latreille, 1817

Suborder Asellota Latreille, 1803

Superfamily Janiroidea Sars, 1897

Family Lepidocharontidae Galassi and Bruce, 2016

Microcharon quilli sp. nov.

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(Figs. 1,2,3,4 and 5)

Material examined

Collected by R. Vonk, June 2015, off the sheltered west coast of the island of St. Eustatius, Caribbean Netherlands with the following catalogue numbers and dive sites: RMNH.CRUS.I.7712 (15 specimens) at EUK 01, Princess Bay, 17°27.827' N, 062°59.209' W, 18 m depth; RMNH.CRUS.I.7713 (11 specimens) at EUK 08, Five Fingers North, 17°27.893' N, 062°59.007' W, 18 m depth; RMNH.CRUS.I.7714 (22 specimens) at EUK 15, Blue Bead Hole,

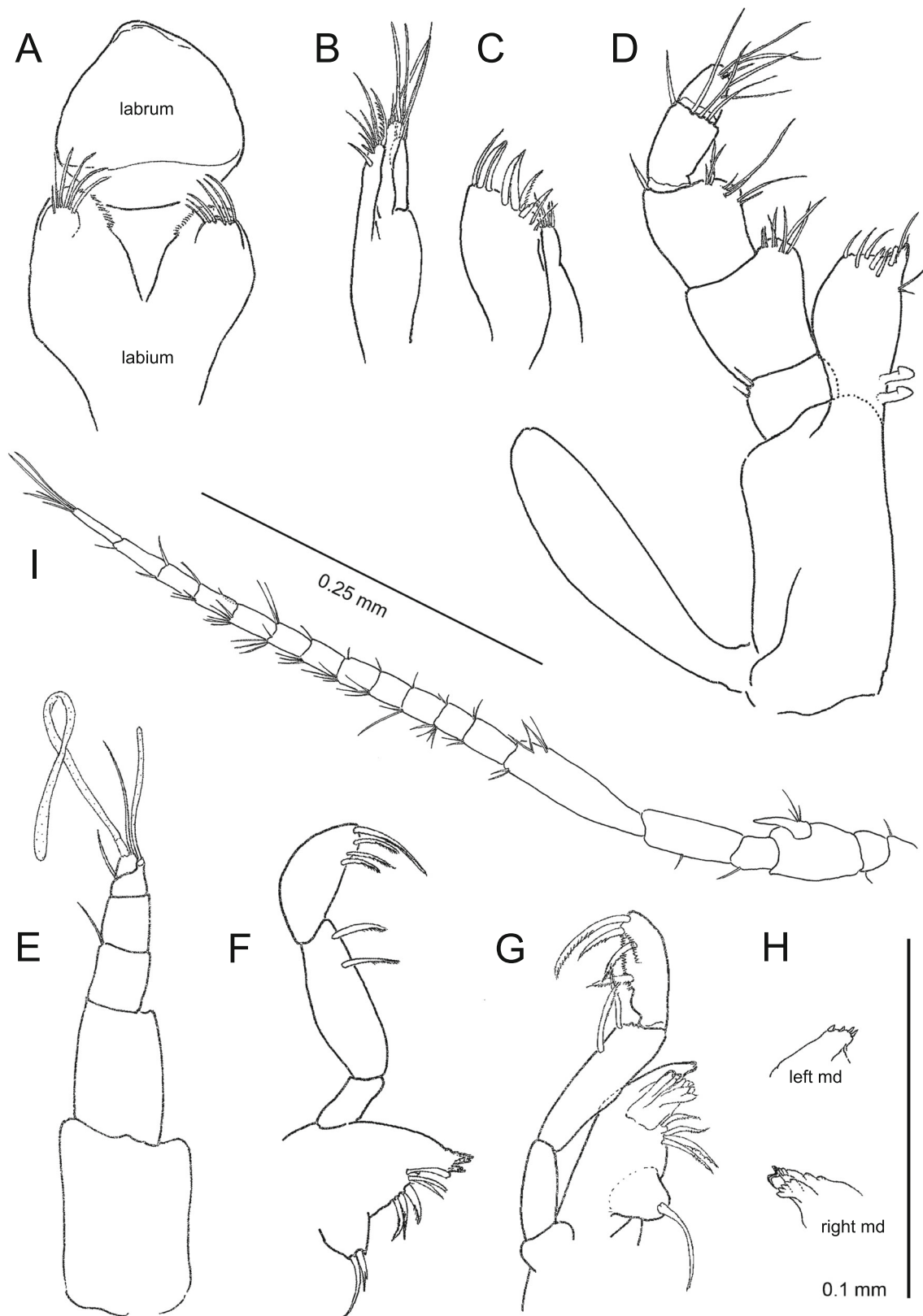


Fig. 2 *Microcharon quilli* n. sp. holotype, RMNH.CRUS.21509, male 1.5 mm: **a** Paragnaths, upper and lower lip. **b** Maxilla. **c** Maxillule. **d** Maxilliped. **e** Antennule. **f** Right mandible and palp. **g** Left mandible and

palp. **h** Paratype, RMNH.CRUS.21511, female 1.0 mm, Left and right mandibles. **i** Holotype, antenna. **a–h** Scale bar: 0.1 mm; **i** adjacent scale bar: 0.25 mm

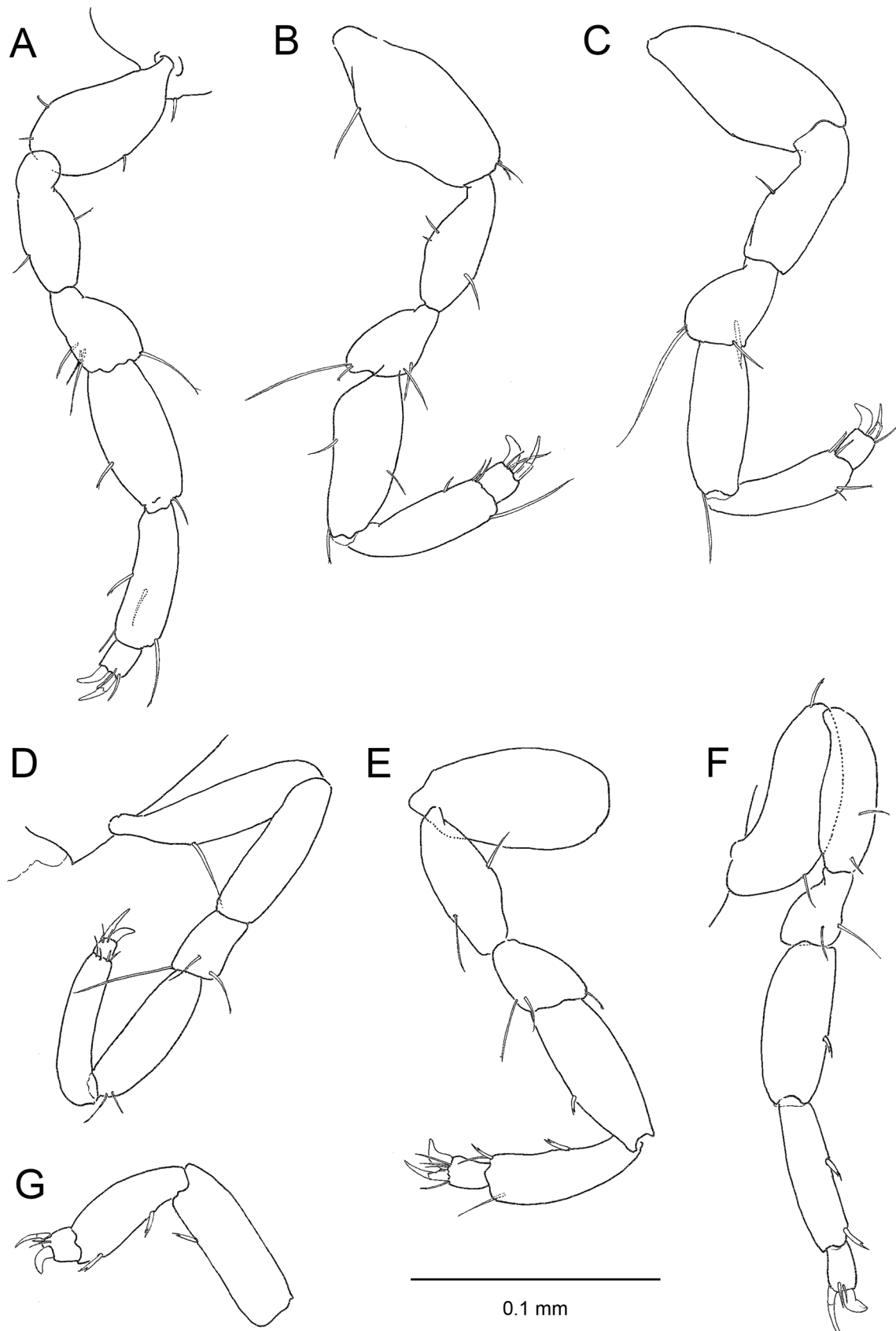


Fig. 3 *Microcharon quilli* n. sp. holotype, RMNH.CRUS.21509, male 1.5 mm. **a** Pereiopod 1. **b** Pereiopod 2. **c** Pereiopod 3. **d** Pereiopod 4. **e** Pereiopod 5. **f** Pereiopod 6. **g** Pereiopod 7, distal segments. **a–g** Scale bar: 0.1 mm

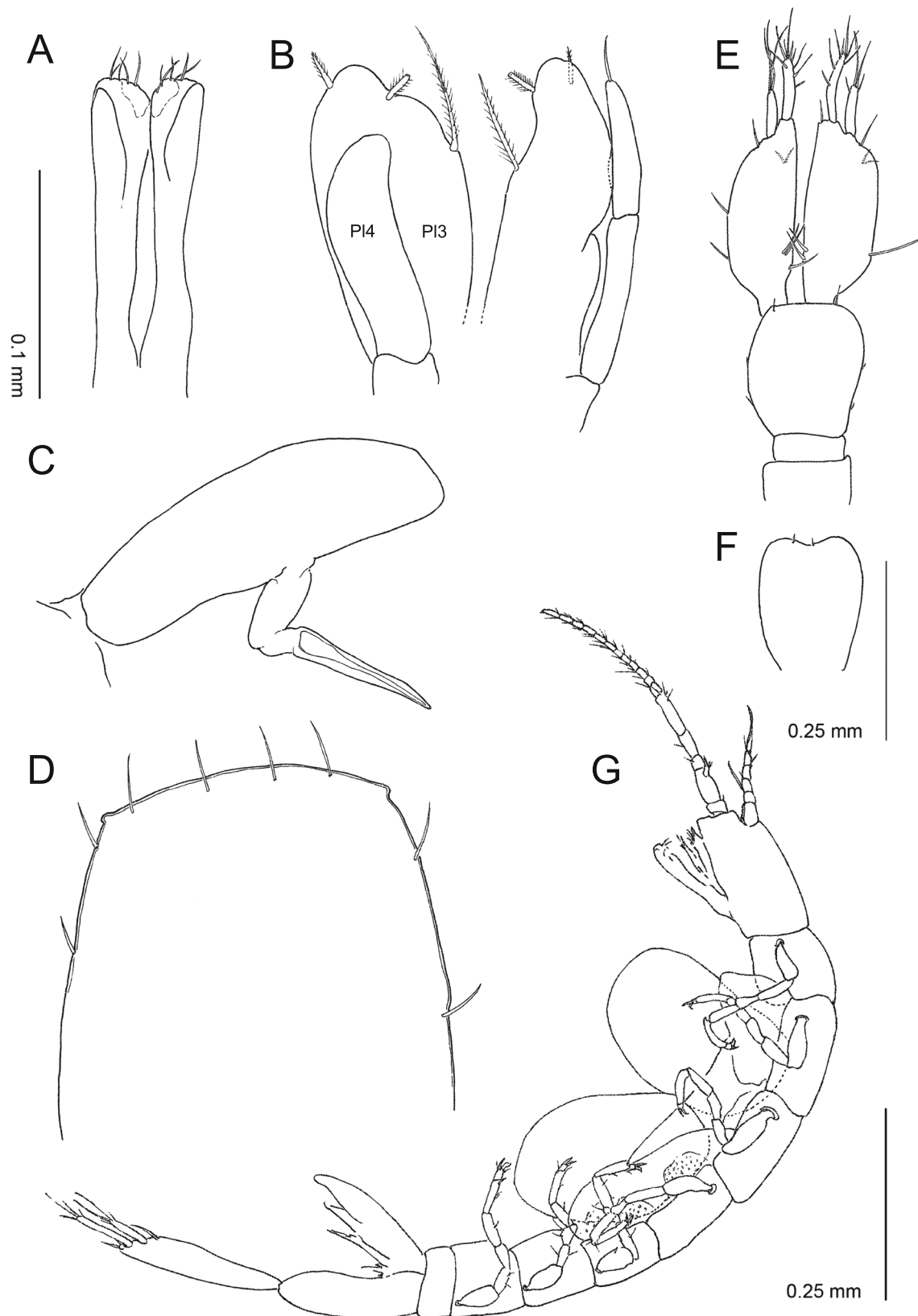


Fig. 4 *Microcharon quilli* n. sp. holotype, RMNH.CRUS.21509, male 1.5 mm. **a** Pleopod 1. **b** Paratype, RMNH.CRUS.21511, female 1.0 mm: pleopods 3 and 4. **c** Paratype, RMNH.CRUS. 21510, male 1.1 mm: pleopod 2. **d** Holotype, male 1.5 mm: pleotelson. **e** Paratype,

RMNH.CRUS.21511, female 1.0 mm: uropods and pleotelson. **f** Pleopod 2. **g** Paratype, RMNH.CRUS.I.7718, female 1.5 mm carrying two eggs. **a–d** Scale bar: 0.1 mm; **e–f** adjacent scale bar: 0.25 mm; **g** adjacent scale bar: 0.25 mm

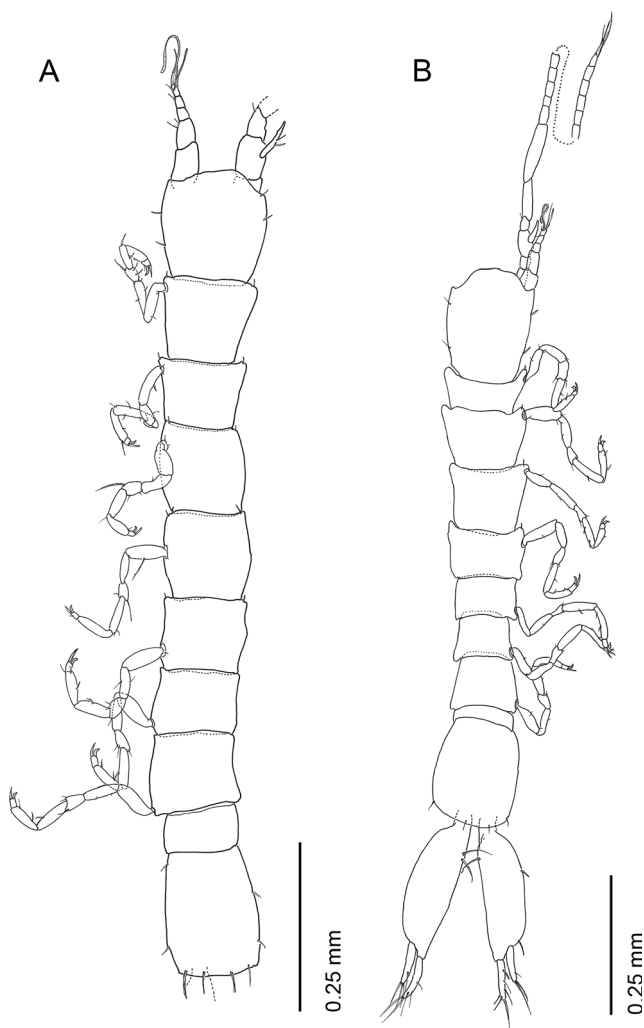


Fig. 5 *Microcharon quilli* n. sp. **a** Paratype, RMNH.CRUS.21510, male 1.1 mm. **b** Paratype, RMNH.CRUS.21511, female 1.0 mm. Appendages pictured on one side only

17°28.550' N, 062°59.670' W, 17 m depth; RMNH.CRUS.I.7715 (one specimen) at EUX 22, Maxima's Reef, 17°27.960' N, 063°00.125' W, 23 m depth; RMNH.CRUS.I.7716 at EUX 25 (19 specimens), Lost Anchors, 17°28.250' N, 063°00.370' W, 22 m depth; RMNH.CRUS.I.7717 (one specimen) at EUX 30, Twin Sisters, 17°30.993' N, 063°00.180' W, 16 m depth.

Holotype, RMNH.CRUS.21509, male, 1.5 mm, EUX 08, Five Fingers North, 17°27.893' N, 062°59.007' W, 18 m depth. Paratypes, RMNH.CRUS.21510, male, 1.1 mm, EUX 08, Five Fingers North, 17°27.893' N, 062°59.007' W, 18 m depth; RMNH.CRUS.21511, female 1.0 mm, EUX 25, Lost Anchors, 17°28.250' N, 063°00.370' W, 22 m depth; RMNH.CRUS.I. 7718, female with 2 eggs, 1.5 mm, EUX 25, Lost Anchors, 17°28.250' N, 063°00.370' W, 22 m depth.

Diagnosis

Body length up to 1.5 mm. Cephalosome is longer than wide, rostrum absent; eyes absent; pedigerous somites longer than wide, somites 2–5 in ovigerous female flattened dorsoventrally with large oostegites (Fig. 1a); uropod with large and broad protopod; antennule with six segments; antenna with 12 flagellum segments and six podomeres; maxilla endite with one robust seta with spinules; maxilliped with large coupling hooks; inner claws of pereopods strongly bent and thick; carpus of all pereopods slightly inflated; carpus of P5–P7 with one robust 'clothespin' seta on inner margin, propodus with two such setae on inner margin; pleopod 3 exopod slender; uropod peduncle curved inwards at basolateral margin, giving it a stalked appearance; pleotelson with pointed corners on posterior margin in male.

Etymology

Species named after the dormant volcano "The Quill" which dominates the landscape of St. Eustatius, above and under water. The volcano has formed diagonal lava 'fingers' with coarse sand in between, well aerated and silt free because of current and wave action. This creates favorable conditions for sand inhabitants such as *Microcharon* species.

Distribution Known thus far only from the type locality in the shallow marine sands on the leeward side of the island of St. Eustatius.

Description

Body length (without antennae and uropods) 1.0–1.5 mm (Fig. 5a, b). Head longer than wide, without a rostrum but with a slightly protruding margin on the frontal side.

Antennule (Fig. 2e) six-segmented, last segment very small. Segment 5 and 6 bear aesthetascs on distal margin; setae seem to be not plumose and are absent on several segments. In male paratype (Fig. 5a), two small setae are present on the second segment.

Antenna (Fig. 2i) with a pointed, one-segmented exopodite, armed with two or three setae. The flagellum counts 12 segments.

Mandibles (Fig. 2f–h). The left mandible (Fig. 2g) has a lacinia mobilis with a forked process on its inner side; four setae on lateral margin between lacinia and molar process. Molar process is a rounded protuberance with one robust seta; palp with two pinnate setae on inner margin of segment 2, and three pinnate seta on finely serrated inner margin of segment 3. Incisor in female lined with four separate teeth (Fig. 2h). Right mandible (Fig. 2f) without lacinia mobilis and with three thin setae and three robust spinulose and bended setae; molar process with two setae; palps as in left mandible.

Paragnaths (Fig. 2a) with six setae on each lobe, planted on a slight protruding fold, inner margin of lobes with fine hairs; labrum rounded and subtriangular.

Maxillula (Fig. 2c) with inner lobe slender, bearing four setae. Outer lobe broad with seven robust setae of which one strongly spinose, and two smaller setae on inner margin.

Maxilla (Fig. 2b) bears three lobes of approximately the same length, inner lobe with oxxne robust spinose comb-like seta, other setae thinner and irregularly placed and of variable length.

Maxilliped (Fig. 2d) with a long, club-like unarmed epipodite. The basipodal endite is distally armed with three larger and three smaller spines, and one longer seta at the inner corner of the endite, this corner hardened and strongly produced; endite mediobasally provided with two exceptionally large coupling hooks. The palp consists of five segments, of which articles 2 and 3 are mesially broad, whereas articles 4 and 5 are narrow and rectangular.

Pereiopods (Fig. 3a–g) biunguiculate, with mostly inflated carpi and strong, broad and sharply curved inner claws on dactyli. Outward claw slender and consisting of two parts or coming from a sheath. P5–P7 have regularly placed forked setae ('clothespin' spines): one on inner margin of the carpus, two on inner margin propodus. Coxal plates minute, of irregular form.

Pleopods. First pleopod in male (Fig. 4a) with five thin seta at apical margin; outer margins at top folded inwards. First pleopod not present in female. Second pleopod (Fig. 4c) of the male suboval, with folded endopodite, distal part filiform, exopodite not discernable; female second pleopod (Fig. 4f) has a subrectangular rounded shape with the medial margin curved inwards, armed with two small setae. Third pleopod not sexually dimorph (Fig. 4b), the exopodite is long and slender, with distal segment bearing one seta; endopodite with three robust spinose setae of which one long and on subapical margin. Fourth pleopod (Fig. 4b) similar in both sexes and consists of a one-segmented unarmed rudimental cone.

Uropod (Fig. 4e) with a shortly stalked, and then a very long and wide, peduncle, longer than pleotelson. Peduncle with two or three setae on basomesial margin. The exopodite is narrow and armed with two or three long terminal setae and two subapical shorter setae. Endopodite longer than exopodite with three subapical setae on inner margin and three on the apex.

Pleotelson (Fig. 4d) in male not rounded at its posterodistal margin but with inconspicuous, pointed corners, and eight marginal and apical setae present.

Remarks

A comparison with the other three *Microcharon* species from the Caribbean leads to the following observations.

Microcharon quilli differs from *M. herrerae* Stock, 1977 (living in a brackish well on Bonaire) in having an antennal flagellum consisting of 12 segments against nine in *M. herrerae*; having one simple robust seta on the molar process of the left mandible instead of two; inner claws on pereiopods plump and robust, fine serrations not present on carpus P4 and P5, setules lacking on medial margin of propodus P1 and P2; female operculum with two setae versus four; with a stalked peduncle on uropod and peduncle significantly longer than pleotelson.

From *M. phreaticus* Coineau and Botosaneanu, 1973 (living in freshwater riverbed interstitial and coastal plain dug wells in Cuba) by having a six-segmented antennule versus five; having an oblong tip on the inner lobe of the maxillule instead of a pointed one; having stout inner claws on the pereiopods versus feeble ones.

From *M. sabulum* Kensley, 1984 (living in coarse calcareous intertidal sand of Carrie Bow Cay, Belize) by lacking a rostrum; by having a six-segmented antennule versus five; in having an antennal flagellum consisting of 12 segments against eight; in having stout inner claws on the pereiopods versus slender ones; by having a narrow first segment of pleopod 3 versus a broad one; by having the uropod peduncle longer than the pleotelson versus of equal length.

Other marine species outside the Caribbean were collected at the Galapagos, New Caledonia, the British Channel, Portugal, Southern France, and Brittany (France). *Microcharon quilli* differs from *M. galapagoensis* Coineau and Schmidt, 1979 (found in coarse sediment in the lower littoral zone of several islands in the Galapagos Archipelago) in having a six-segmented antennule versus five; having two aesthetascs on terminal segment of antennule; having a much shorter endopodite on male pleopod 2, without long and thin pointed process; having a broader uropod without curvature at the posterior end of the peduncle.

From *M. salvati* Coineau 1970 (living in coral sand, New Caledonia) by having a six-segmented antennule versus five; having 12 flagellum segments on the antenna versus 10; having a flat, slightly concave anterior margin of the cephalon versus a blunt rostrum; having five short setae at the tip of both halves in male pleopod 1 instead of four plus one long seta; having a curved posterior margin of pleopod 2 in female versus a straight margin.

From *M. heimi* Coineau 1970 (living in coral sand, New Caledonia) by having a six-segmented antennule versus five; having 12 flagellum segments on the antenna versus nine; having two aesthetascs on the 5th segment of the antennule versus one; having broad and bended inner claws on the pereiopod dactyli versus more slender and not hooked; having rounded tips of the pleopod 1 versus pointed ones.

From *M. harrisi* Spooner, 1958 (living in shell gravel off the coast of Southern England) by having a six-segmented antennule versus five; having 12 flagellum segments on the

antenna versus ten; lacking an endopodal swelling on the peduncle of male pleopod 2; having a curved posterior margin of pleopod 2 in female versus a straight margin.

From *M. monnioti* Bocquet, 1970 (living in marine sands near Roscoff, Brittany, France) by having a wide and large uropod peduncle and short and thin rami versus the opposite combination.

From *M. teissieri* (Levi, 1950) living in coarse marine sand near Roscoff, Brittany, France, by having a six-segmented antennule versus five; having three pinnate setae on segment 3 of the mandible palp versus two; having a differently shaped peduncle of the uropod.

From *M. marinus* Chappuis and Delamare Deboutville, 1954 (living in sandy beaches in southern France) by having a pinnate setae among the simple setae on inner lobe of maxilla; having three spinulose setae on the posterior margin of endopodite of pleopod 3; having a broad peduncle segment in uropod 3.

From *M. coineauae* Galhano 1970 (living in littoral sands at the mouth of the river Douro, Portugal) by having a six-segmented antennule versus five; having 12 segments on the antenna versus eight; having a pinnate setae among the simple setae on inner lobe of maxilla; having three spinulose setae on the posterior margin of endopodite of pleopod 3; having an inwardly curved posterior margin of the female pleopod 2 versus a straight margin.

In addition to these differences, there is the overall uniqueness of the squared corners of the male pleotelson, the lack of plumose setae on antennules and pereopods, and the very robust and hooked inner unguis on the dactyli of the pereopods.

Discussion

The antennule of *Microcharon quilli* consists of six segments, which is an unusual number, as it is in contrast with the observation (Stock 1977) that the fully marine *Microcharon* species have only five segments. The top of the antennule has a clear aesthetasc that is long and broad, but a smaller one is visible too. When checked with high magnification, this aesthetasc does not sprout from the top segment (as aesthetascs mostly occur in singles per segment), but comes from a small segment just below the top segment. It resembles the situation as shown in *Lepidocharon priapus* Galassi and Bruce, 2016, and *Lepidocharon lizardensis* Galassi and Bruce, 2016, displaying this configuration clearly in a SEM photograph. In *Microcharon salvati*, found in coralline white sands off New Caledonia, a situation is drawn in which two aesthetascs are placed, one apically and one subapically on a sort of pedestal; here the division into two segments is not visible. Upon re-examining the type specimen of *M. herreraei*, present in the Naturalis Biodiversity Center

collection in Leiden, we found a similar situation as in *M. quilli* n. sp.: a long terminal aesthetasc, and a smaller one coming from the segment just below the terminal segment. This supports the probability that the antennule in full marine species consist of six segments, instead of five segments, which was the original diagnostic feature. Re-examining all known marine species may change the outcome of the number of segments significantly.

The morphological differences between the marine *Microcharon* species are rather subtle, as can be expected within genera that are almost exclusively found in the same type of microhabitat. They are often reported from places far apart from each other on the globe, and genetic connectivity between these populations is considered improbable. However, well-sorted, sandy sediments are present in a narrow zone along marine coasts (Fenchel 1987), and a continuum of species, of which most are undiscovered, might be in place. Therefore gradual, not abrupt, morphological differences are expected in the marine species of *Microcharon*, along a worldwide chain of these littoral coarse sand habitats. These are interrupted only by the Atlantic and Pacific Ocean that form truly deep basins. It is interesting in this respect to compare the distribution of the tiny worm-like asellote isopods of the genus *Microcharon* with that of the equally small amphipod wormshrimp *Ingolfiella* Hansen, 1903 (Vonk and Schram 2003; Vonk and Nijman 2006). *Microcharon* and *Ingolfiella* are usually found together in the shallow marine interstitial. However, where *Microcharon* has its main species radiation in continental groundwater (Coineau and Botosaneanu 1973), and but a few species present in the littoral fringe, the ingolfiellid amphipods occur mainly in marine environments (Rubal and Larsen 2012; Vonk and Jaume 2014a, b) and also in deep oceanic seafloor habitats, with freshwater representatives in near-coastal continental groundwater (Ruffo and Vonk. 2001) and brackish water inhabitants in anchialine pools (Vonk and Iannilli 2013). As isopods are supposed to be much older (Carboniferous) than amphipods (Late Eocene), according to their fossil record (Schram 1986; Weitschat and Wichard 2010), the differences in distribution may reflect how the typical and vertically restricted habitat type of the shallow marine interstitial is shared by crustaceans with origins of different stages in the Earth's history in that particular ecological niche.

As was noticed earlier (Coineau 1970), it is likely that at least as many species are present in the marine realm as are currently found in riverbeds, freshwater wells, and springs. This sampling bias of collecting on land could potentially be causing overrepresentation of freshwater species.

The females in the samples hold two large eggs between large brood lamellae. The eggs are extremely large in relation to the body size of the female, and must form a hindrance in moving quickly through the interstices in a sandy bottom. Investment in a small number of eggs is predominantly an

indication of a stable environment, with a controlled release of the young. Having so few eggs also summons a high fecundity in producing subsequent broods over time. It was observed in *M. marinus* that the duration from the appearance of two eggs until the release of one young — the other egg is expelled prematurely from the marsupium — is about 2 months (Coineau 1971). The longevity, or lifespan, of *Microcharon* was rated around 2 years (Coineau 2000).

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